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AN EXPLORATORY STUDY OF THE DEVELOPMENT OF MORE EFFECTIVE TESTING PROGRAMS FOR STUDENTS IN DIFFERING CULTURAL BACKGROUNDS.

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*PREDICTIVE ABILITY, *PREDICTIVE VALIDITY, *INTELLIGENCE TESTS, *CULTURAL DIFFERENCES, *SOCIOECONOMIC BACKGROUND, HIGH SCHOOL STUDENTS, FEMALES, ETHNIC GROUPS, NEW YORK, NEW YORK CITY, STANDARD PROGRESSIVE MATRICES, D. 48 TEST

THE PREDICTIVE ABILITY OF TWO INTELLIGENCE TESTS ON A CROSS-CULTURAL SAMPLE WAS STUDIED. THE STANDARD PROGRESSIVE MATRICES AND THE D. 48 TEST WERE ADMINISTERED TO 1,579 GIRLS IN GRADES 9 THROUGH 12. OTHER TEST SCORES WERE OBTAINED FROM STUDENT RECORDS. THE CROSS-CULTURAL GROUPS CONSISTED OF (1) INDO-EUROPEAN, (2) SPANISH-AMERICAN, (3) NEGRO, AND (4) CHINESE. MEASURES WERE MADE OF ACHIEVEMENT, SOCIOECONOMIC LEVEL, INTELLIGENCE, AND ABILITY. CORRELATIONS AND COMPARATIVE PROCEDURES WERE EMPLOYED IN ANALYSES. SCORES ON BOTH TESTS EMPHASIZED MATHEMATICS APTITUDE AND ACHIEVEMENT. NEITHER OF THE TESTS VALIDLY PREDICTED PERFORMANCE LEVELS, NOR DID THEY DIFFERENTIATE AMONG THE ETHNIC GROUPS. FUTURE RESEARCH WAS SUGGESTED TO SHOW HOW INSTRUMENTS MAY DIFFERENTIATE WITHIN ETHNIC GROUPS AS SOCIOECONOMIC RANK CHANGES. (RS)

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Final Report

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Project title: An exploratory study of the development of more effective testing programs for students of differing cultural backgrounds, FINAL REPO

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Purpose

The Standard Progressive Matrices (1938) and The D. 48 Test have been designed to measure an individual's underlying intellectual capacity, irrespective of specific training. This study was undertaken to investigate these three questions about the two tests: (a) How valid are the Standard Progressive Matrices (1938) and The D. 48 Test as predictors of academic potential in a sample of high school girls of differing cultural and ethnic backgrounds? Do the two tests differentiate between verbal and mathematics facility when these two characteristics are expressed in terms of school achievement? (b) Do the Progressive Matrices (1938) and The D. 48 Test seem to be measuring the same aspects of intellectual capacity? (c) Do the Standard Progressive Matrices (1938) and The D. 48 Test successfully discriminate among a sample of testees described by academic level and ethnic group membership?

Tests and Other Quantitative Indices

Scores from the following tests have been used in the investigation: the Standard Progressive Matrices (1938); The D. 48 Test; Otis Quick-Scoring Mental Ability Test, gamma form; College Entrance Examination Board, Scholastic Aptitude Test, verbal and mathematics sub-tests; College Entrance Examination Board, Preliminary Scholastic Aptitude Test, verbal and mathematics sub-tests; and the Cooperative Entrance Examination, verbal and numerical sub-tests.

The Standard Progressive Matrices (1938) is made up of five sets of twelve incomplete matrix problems--a total of 60 matrices.

Raven (1963, p.1) describes a matrix as an incomplete "meaningless figure" designed to represent a system of relations. The testee is asked to conceive the nature of the relationships underlying each matrix and complete the pattern by selecting one of six or eight alternatives given with each problem. By set and within set the matrices become progressively more difficult.

Although the Matrices is generally considered a good "g-test" (Raven, 1963; Burke, 1958) with negligible spatial loadings, Smith (1964) notes that when administered to groups of women it has a consistent but low space (k) loading.

The D. 48 Test includes 44 domino problems representing varied types of ideational progressions from simple to relatively complex. The testee is required to discern the thought pattern underlying each domino series and complete the last domino in the unit. The domino problems are open-end; no alternatives are given. The domino test is also considered a good "g-test". (Pichot, 1949; Gough and Domino, 1963).

Both of the above instruments are non-verbal group tests; both are designed to measure ability to solve non-verbal problems of wide range; neither presents major difficulties in administration, scoring or interpretation and both may be completed by testees in a relatively short time period. Although the tests are widely used in European countries where they have extensive research bibliographies (Raven, 1963; Burke, 1958; Calonghi, 1956; Pichot, 1949), neither has received comprehensive use in the United States. The D. 48 Test is available in the latter country in an experimental edition only.

The Otis Quick-Scoring Mental Ability Test, gamma form, gives

a single measure of scholastic aptitude ("I.Q."). The test is primarily one of verbal ability. Evidence gathered from the wide use of the test indicates that it has reasonable predictive validity when school achievement is the criterion. (For a detailed description of this instrument and other standardized tests used in this study see Buros, 1965.)

The College Entrance Examination Board, Scholastic Aptitude Test, verbal and mathematics sub-tests and Preliminary Scholastic Aptitude Test, verbal and mathematics sub-tests are basically conventional general "intelligence" tests. The former is designed for the bright upper high school level; the latter for the middle years of high school.

The Cooperative Entrance Examination is also a general type of scholastic "intelligence" test but is designed for the entering high school freshman. The relationship between results obtained on the Cooperative Examination and the Scholastic Aptitude Test by a sample drawn from the same population as the sample included in this study is expressed by a coefficient of correlation of .58. (Reported in the Manual, Cooperative Entrance Examination.)

The socio-economic status of the members of the sample being studied is described in terms of classification of occupation of the major family provider. Two independent rating scales have been used, chiefly to check out the occupational ranks. A coefficient of correlation of .89 was obtained between the ratings on the two scales for the sample used in this study.

The two occupational rating scales used were (a) Warner's (1957) seven-point occupational rating scale, and (b) the

Revised Minnesota Occupational Rating Scale (Paterson et al., 1953).

Warner classifies jobs in seven occupational categories (professionals, proprietors and managers, business men, clerical and kindred workers, manual workers, protective and service workers, and farmers) on a seven point scale. The points are assigned on the basis of the degree of skill and amount of prestige attached to the job. Warner includes occupation as one of four characteristics (the others: source of income, house type and dwelling area) needed to derive an individual's Index of Status Characteristics; he notes that occupation correlates .91 with the total I.S.C. The occupational scale alone is used to indicate socio-economic status in this study. An eighth point has been added to the scale by the investigator to include welfare recipients, etc.

The Revised Minnesota Occupational Rating Scales describe occupations in terms of weighted ability patterns. These patterns indicate the complexity of human abilities required in various occupations. Abilities are subsumed under seven categories: academic ability, mechanical ability, social ability, clerical ability, musical or artistic abilities, and physical ability. The "prestige" of a job depends upon its weighted ability pattern score. In general, an occupation which requires a good degree of skill in a number of abilities will receive a high ability pattern score.

The following ethnic group classifications were used in this study.

(1) Indo-European, American. This group formed the largest

category and included several well defined sub-groups of the total ethnic group. The largest of these sub-groups were those whose members were of Italian, Irish, or Slavic descent.

(2) Spanish speaking. This group, the second largest, was composed of all members of the sample whose native language was Spanish or a Spanish dialect. While this group was made up to a large degree of individuals from Puerto Rico, Cuba and the Dominican Republic, Latin American countries were also well represented.

(3) Negro, American. This group was made up of American Negroes.

(4) Others. A very small number of students belonged to no one of the three groups described above; they were all Chinese.

For the purpose of this investigation, achievement was measured in terms of school grades. Grade point averages in two academic areas, English and mathematics, were obtained from students' records,

Procedure

The Standard Progressive Matrices (1938) and The D. 48 Test were administered as untimed tests to the sample in two different sessions by the investigator. Other test scores, the Otis, Scholastic Aptitude Tests, and Cooperative Entrance Examination, as well as English and mathematics grade point averages were obtained from the students' records.

The Otis had been routinely administered to every freshman in September of her first year, Scholastic Aptitude Tests were administered in November and March of the Junior year;

Preliminary Scholastic Aptitude Tests in May of the Sophomore year. The most recent aptitude score was used for each sophomore, junior and senior subject. The Cooperative Entrance Examination was taken by the freshmen in May prior to their high school entrance.

Occupations of parent(s), etc., and ethnic group membership were obtained from the students in the sample.

The Sample

The total sample included in this study is representative of the population of girls who attend the large four-year metropolitan high school in which this study was conducted. This school is associated with two 9-10 year schools; students from the latter schools who want to complete high school generally transfer to the former for grades 11 and 12. The population of the four-year high school is therefore split about 60%/30% between the upper and lower halves of the school

For the purposes of this study the sample is described by the following characteristics: (a) year in school and ethnic group membership; (b) socio-economic status by occupational classification of source of income of major family provider; (c) indices of academic ability and performance: (1) scholastic aptitude ("I.Q."), (2) verbal and mathematics aptitude, and (3) English and mathematics achievement.

(a) <u>Year in school and ethnic group membership</u>. The total sample (N=1579) was distributed in grades 9 through 12 and in four ethnic groups (see Table I, following). The ethnic groups

TABLE I

Classification of Sample by Year in School and Ethnic Group
N=1579

Year	Ethnic Group	n	%	N	%	
4	1	335	66			
	2	107	21			
	3	60	12			
	4	6	1	508	32	
3	1	235	61			
	2	81	21			
	3	62	16			
	4	9	2	387	25	
2	1	248	75			
	2	56	17			
	3	14	4			
	4	12	4	330	21	
1	1	251	71			
	2	82	23			
	3	9	3			
	4	12	3	354	22	N=1579

include: (1) Indo-European, American; (2) Spanish speaking; (3) Negro, American; and (4) Other, Chinese.

(b) Socio-economic status by occupation of major provider. Occupations of major family providers were classified on two separate rating scales. Each scale has been described in the section of this report dealing with "Tests and Other Quantitative Indices". A coefficient of correlation of .89 was obtained in the study when ratings of the sample on the Warner and Revised

Minnesota Occupational Rating Scales were compared.

TABLE III

Classification of Sample by Ethnic Group and Mean Socio-Economic Status Rank

Ethnic Group	Socio-Economic Status Rank Mean	s.d.*	n	N
1	5.3686	1.5245	1069	
2	5.7108	1.5795	325	
3	5.6207	1.37995	145	
4	5.5385	1.2577	39	1579

*=standard deviation

Table II above shows the sample distributed by ethnic group and socio-economic status by occupational rank. The scale included in this table is Warner's occupational rating scale. All four ethnic groups can be described by a mean occupational value of approximately the same rank, 5.5, and all four ethnic groups exhibit about the same degree of variability around this mean. A mean of 5.5 on the 8-point scale would represent a lower-middle socio-economic status rating.

On a descriptive level several factors are worth considering about the figures in Table II. (a) Many of the occupations, especially in ethnic group 1, can be termed "hereditary" in terms of the sub-ethnic group to which the job holder belongs. For example, the occupation "longshoreman" is distinctly characteristic of the sub-group of Slavic descent within the larger Indo-European group. (b) The occupations clustering in ethnic group 2, tend to be covered by semi-skilled to skilled factory worker job

descriptions; occupations of the same rank in ethnic group 3, are generally covered by office/worker/clerical aid types of descriptions. (c) All the ethnic groups share the janitorial-porter types of occupations. However, among the female members of the occupational groups considered in this study, the "night office cleaner" of ethnic group 1, becomes the "domestic" of ethnic group 3, and is relatively scarce in ethnic group 2.

(c) Indices of academic ability and performance: (1) scholastic aptitude ("I.Q."), (2) verbal and mathematics aptitude, and (3) English and mathematics achievement. Tables III through V, which follow, give a distribution of the means and standard deviations of scholastic aptitude scores, verbal and mathematics aptitude scores, and English and mathematics achievement, all three major divisions by ethnic group.

Scholastic aptitude scores are expressed in terms of the standard "I.Q." scores provided for the Otis Quick-Scoring Mental Ability Tests. Verbal and mathematics aptitude standard scores have a potential range of total score from 20 to 80, with a standard score mean of 50, and a standard deviation of 10. English and mathematics achievement scores are simple averages of school grades.

The following general inferences about the academic ability of the sample used in this study can be made on the basis of the average group performance on the three previously described indices.

(1) The scholastic aptitude ("I.Q.") is approximately average for this sample; this is, the mean "I.Q." clusters around 101. The mean scholastic aptitude score for ethnic

TABLE III

Mean Scholastic Aptitude Scores by Ethnic Group

grades 9 through 12

Ethnic Group	Mean	s.d.	n	%	N
1	106.2975	9.7807	1069	68	
2	100.3405	9.3653	326	21	
3	101.9448	8.4656	145	9	
4	101.0113	10.0113	39	2	1579

TABLE IV

Mean Aptitude Scores in Verbal and Mathematics Ability by Ethnic Group

grades 10 through 12

Ethnic Group	Verbal Mean	s.d.	Mathematics Mean	s.d.	N	%
1	37.559	9.845	37.131	8.780	818	67
2	36.672	8.883	35.602	6.735	244	20
3	37.299	8.244	36.097	7.374	136	11
4	37.037	9.632	42.370	9.329	27	2
					1225=N_t	

group 1 is slightly higher but not beyond the average range.

(2) The "average" character of this sample is also evident in the mean performance levels on measures of verbal and mathematics aptitude. With the exception of the small number of subjects making up ethnic group 4, who score high for the total sample in mathematics aptitude, the mean scores in both aptitude categories approximate 37. This score is roughly 1.3 standard

deviations below the standard score mean of 50 on the measurement scale in use here.

TABLE V

Mean Achievement Scores in English and Mathematics by Ethnic Group

grades 9 through 12

Ethnic Group	English Mean	s.d.	Mathematics Mean	s.d.	N	%
1	78.769	6.819	73.186	11.955	1069	68
2	77.359	7.399	71.132	11.431	326	21
3	78.338	6.656	71.697	12.073	145	9
4	79.359	7.156	77.103	11.039	39	2
					1579=N_t	

(3) The group means in English and mathematics achievement again indicate average performance. The achievement in English--while remaining within the average range--is slightly higher than that in mathematics and the variability of performance (as indicated by the standard deviation) is somewhat less for the former subject area.

(4) These indices of academic performance give an indication of the nature of the sample as far as school work is concerned but do not isolate any causal factor(s) behind performance levels. An investigation of such factors is not a defined part of this study but they can be hypothetically ascribed to such behavioral characteristics as direction and intensity of motivation, lack of language facility, limited academic potential, etc.

Analysis of Results

(1) <u>The relationship between scores obtained on the Standard Progressive Matrices (1938) and The D. 48 Test and stated variables, including indices of academic potential.</u>

Product-moment coefficients of correlation were computed between scores obtained by the sample of students on (a) the Standard Progressive Matrices (1938) and 13 independent variables which included indices of academic potential, and (b) The D. 48 Test and the same independent variables. Tables VI and VII show the inter-correlations among these variables.

Two multiple regression analyses, one from the inter-correlations of the scores on the Standard Progressive Matrices (1938) and the other for The D. 48 Test scores were completed. The purpose of the calculations was to obtain an indication of the degree of predictive relationship which existed between (a) the Standard Progressive Matrices (1938) and (b) The D. 48 Test and academic potential, ethnic group membership, cultural status and years of high school completed as measured in terms of the specific independent variables used in this investigation.

The 13 independent variables (and identifying numbers) were:

I.D.	Variable
1	Year in school: 1 through 4 years.
2 - 5	Ethnic group.
6 - 7	Socio-economic status by occupational rank: (6) Revised Minnesota Occupational Rating Scale, and (7) Warner's occupational rating scale.
8	Scholastic aptitude ("I.Q.").
9 - 10	Verbal (9) and mathematics (10) aptitude.
11 - 12	English (11) and mathematics (12) achievement.

TABLE VI

Product Moment Coefficients of Correlation among Scores on the Standard Progressive Matrices (1938) & Stated Variables (N=753)

	Grade	E.G.-1	E.G.-2	E.G.-3	E.G.-4	S.E.S.-Minn.	S.E.S.-Warner	"I.Q."	S.A.T.-V	S.A.T.-M	Ach.-Eng.	Ach.-M	Yrs.-Math.	P.M.('38)
Grade		-.06	-.01	.08	.02	.05	.06	-.06	-.13	-.17	-.03	-.03	.35	.16
E.G.-1	-.06		-.69	-.52	-.18	.09	.05	.27	.07	.08	.06	.02	-.08	.06
E.G.-2	-.01	-.69		-.20	-.07	-.08	-.02	-.22	-.06	-.07	-.08	-.01	-.06	.01
E.G.-3	.08	-.52	-.20		-.05	-.03	-.06	-.10	-.04	-.07	.00	-.03	.16	-.10
E.G.-4	.02	-.18	-.07	-.05		.02	.03	-.03	.02	.10	.02	.06	.07	.04
S.E.S.-Minn.	.05	.09	-.08	-.03	.02		.89	.19	.12	.10	.02	-.02	.04	.10
S.E.S.-Warner	.06	.05	-.02	-.06	.03	.89		.16	.09	.08	.01	-.04	.06	.11
"I.Q."	-.06	.27	-.22	-.10	-.03	.19	.16		.62	.58	.51	.30	.14	.35
S.A.T.-V	-.13	.07	-.06	-.04	.02	.12	.09	.62		.61	.59	.30	.16	.21
S.A.T.-M	-.17	.08	-.07	-.07	.10	.10	.08	.58	.61		.38	.41	.21	.34
Ach.-Eng.	-.03	.06	-.08	.00	.02	.02	.01	.51	.59	.38		.58	.30	.20
Ach.-M	-.04	.02	-.01	-.03	.06	-.02	-.04	.30	.30	.41	.58		.38	.27
Yrs.-Math.	.36	-.08	-.06	.16	.07	.04	-.06	.14	.16	.21	.30	.38		.23
P.M.('38)	.16	.06	.01	-.10	.04	.10	.11	.35	.21	.34	.20	.27	.23	

TABLE VII

Product Moment Coefficients of Correlation among Scores on The D. 48 Test and Stated Variables. (N=1265)

	D. 48	Grade	E.G.-1	E.G.-2	E.G.-3	E.G.-4	S.E.S.-Minn.	S.E.S.-Warner	"I.Q."	S.A.T.-V	S.A.T.-M	Ach.-Eng.	Ach.-M	Yrs.-Math.
D.48		.17	.06	-.05	-.04	.03	.08	.07	.21	.18	.33	.24	.38	.25
Grade	.17		-.05	-.01	.14	-.06	.06	.08	-.07	-.30	-.37	-.04	.04	.66
EG-1	.06	-.05		-.75	-.44	-.25	.12	.09	.03	.12	.11	.09	.04	-.07
EG-2	-.05	-.01	-.75		-.15	-.08	-.13	-.09	-.01	-.09	-.09	-.10	-.05	-.05
EG-3	-.04	.14	-.44	-.15		-.05	-.01	-.03	-.04	-.06	-.10	-.01	-.04	.19
EG-4	.03	-.06	-.25	-.09	-.05		-.02	-.01	-.02	-.03	.08	.02	.06	.01
SES-Minn.	.08	.06	.12	-.13	-.01	-.02		.88	.02	.10	.07	.05	.03	.08
SES-W.	.07	.08	.09	-.09	-.03	-.01	.88		.01	.09	.06	.04	.02	.09
I.Q.	.21	-.07	.03	-.01	-.04	-.02	.02	.01		.12	.32	.01	.04	.02
SAT-V	.18	-.30	.12	-.09	-.06	-.03	.10	.09	.12		.70	.57	.34	-.07
SAT-M	.33	-.37	.11	-.09	-.10	.08	.07	.06	.32	.70		.43	.41	-.14
Ach.-Eng.	.24	-.04	.09	-.10	-.01	.02	.05	.04	.01	.57	.43		.61	.17
Ach.-M	.38	.04	.04	-.05	-.04	.06	.03	-.02	.04	.34	.41	.61		.27
Yrs.-Math.	.25	.66	-.07	-.05	.19	.01	.08	.09	.02	-.07	-.14	.17	.27	

13 Years of high school mathematics completed: 1 through 4 years.

Data presented in Table VIII gives the coefficient of multiple correlation (R) between scores on the Standard Progressive Matrices (1938) and the 13 independent variables as .4681. In this case the coefficient of multiple determination (R^2) indicates that 21.91% of the variance in the Standard Progressive Matrices (1938) scores is accounted for by the variance in scores on measures of the independent variables; 78.09% of the variance is not determined. The R between The D. 48 Test scores and the same 13 independent variables is .5121. The R^2 associated with this multiple correlation coefficient shows that 26.22% of the variance in The D. 48 Test scores is accounted for by variance in scores on measures of the independent variables; 73.78% of the variance is still to be accounted for.

TABLE VIII

Multiple Correlation Coefficients (adjusted), Coefficients of Multiple Determination (adjusted), Coefficients of Multiple Non-Determination, and Standard Errors of Multiple R for the Standard Progressive Matrices (1938), The D. 48 Test and 13 Independent Variables

Test	N	$_cR$	$_c\sigma_R$	$_cR^2$	K^2
P.M.(1938)	753	.4681	5.3514	.2191	.7809
D.48 Test	1265	.5121	5.3786	.2622	.7378

One could say that for the sample under study the combination of 13 selected independent variables, for the most part associated with performance in school, would be approximately 22% efficient in predicting Standard Progressive Matrices (1938)

scores; 26% efficient in predicting this group's scores on The D. 48 Test.

The standard partial regression coefficients (β-coefficients) are listed in Table IX. Those independent variables making significant contributions to prediction of scores on the Progressive Matrices (1938) are mathematics aptitude and achievement, year in school and scholastic aptitude ("I.Q."). Independent variables making significant contributions to the prediction of scores on The D. 48 Test are mathematics aptitude and achievement, year in school, scholastic aptitude ("I.Q.") and number of years of high school mathematics completed.

The significance of the contributions of the β-coefficients should be interpreted in terms of the obtained coefficients of multiple correlation. For example, variances in scores on measures of mathematics aptitude and achievement, "I.Q.", and years of high school completed would make significant contributions to predicting 22% of the variance in the scores obtained on the Standard Progressive Matrices (1938).

Partial correlation coefficients between the dependent variables and each independent variable are listed in Table X. No coefficient indicates a strong relationship between the variables. Partial coefficients of correlation between scores on the Standard Progressive Matrices (1938) and mathematics aptitude and achievement and scholastic aptitude ("I.Q.") are significantly different from hypothesized coefficients of zero. Partial coefficients of correlation between scores on The D.48 Test and the same three independent variables are significant.

TABLE IX

Standard Partial Regression Coefficients (β) for the Standard Progressive Matrices (1938), and The D. 48 Test and 13 Independent Variables.

Variable	P.M.(1938), N=753 β-coefficient	D. 48 Test, N=1265 β-coefficient
1	.1863**	.2265**
2	-.0439	.0193
3	.0317	-.0023
4	-.0894	-.0417
5	.0064	-.0113
6	-.0556	.0413
7	-.0982	.0116
8	.2599**	.1167**
9	-.0916	-.0673
10	.2661**	.3343**
11	-.0515	-.0162
12	.1386**	.2301**
13	.0647	.0857*

**t sig. > .01
*t sig. > .05

TABLE X

Partial Coefficients of Correlation between the Standard Progressive Matrices (1938) and The D. 48 Test and 13 Independent Variables

Variable	P.M.(1938), N=753 partial coefficient	D. 48 Test, N=1265 partial coefficient
1	.1866	.1801
2	-.00003	.00001
3	.00002	-.000001
4	-.00008	-.00004
5	.00001	-.00002
6	-.0287	.0224
7	-.0507	.0063
8	.1972**	.1249*
9	-.0671	-.0485
10	.1750**	.2306**
11	-.0385	-.0128
12	.1155*	.1906**
13	.0605	.0695

**t sig. > .01
*t sig. > .05

The following generalizations can be drawn from the preceding data and stated in terms of the sample studied in this investigation.

(1) The scores on neither the Standard Progressive Matrices (1938) nor The D. 48 Test give evidence of being validly predicted from academic performance when such performance is measured in terms of the variables described above. Approximately one-fifth of the variance in the scores obtained on the former instrument is accounted for by variance in scores obtained on measures of the stated independent variables, including indices of academic performance, used in this study; about one-fourth of the variance in scores obtained on the latter instrument is accounted for by variance in the independent variables.

(2) The standard partial regression coefficients (β-coefficients) which contribute significantly to prediction of scores on the Standard Progressive Matrices (1938) and The D. 48 Test are those associated with mathematics aptitude and achievement, scholastic achievement ("I.Q.") and years of high school completed.

(3) The partial coefficients of correlation between scores on the Standard Progressive Matrices (1938) and scores on The D, 48 Test and the scores obtained on measures of the independent variables show a significant relationship between scores on the two instruments and mathematics aptitude and achievement and scholastic aptitude ("I.Q.").

(2) T<u>The relationship between scores on the Standard Progressive Matrices (1938) and scores on The D. 48 Test</u>.

Coefficients of correlation among certain variables were

obtained for a sub-group of 351 of the 11th and 12th-grade students included in the total sample used in this study (Table XI reproduces a correlation matrix of the major variables). These variables were the Standard Progressive Matrices (1938) total score and scores on sub-tests A, B, C, D, & E; The D. 48 Test total score and individual item scores; mathematics and verbal aptitude measures; English and mathematics achievement measures; number of years of mathematics completed; and ethnic group membership.

The matrix of correlations obtained from scores on measures of these variables was factor analyzed by the centroid method and seven orthogonal factors extracted. The factors are shown in Table XII.

The purpose of the analysis was to note whether or not, for the sample described, an inter-relationship would be evident between the scores on the Standard Progressive Matrices (1938) and those obtained in The D. 48 Test, and to observe any cluster patterns of the individual items on The D. 48 Test. The matrix of inter-correlations (see Table XI) indicates no impressive amount of common variance among the indices listed although interesting trends are evident (for example, the coefficients of correlation obtained between scores on measures of verbal aptitude, mathematics aptitude and The D. 48 Test). The extracted factors could be expected to represent only a rather crude, but possibly speculative, simplification of the variables involved.

Factor IV is clearly an "academic ability or performance" factor. It includes the aptitude and achievement measures and number of years of mathematics completed.

Factor VII is the "Progressive Matrices" factor; it includes

TABLE XI

Coefficients of Correlation Among Scores Obtained on Stated Variables by 351 11th and 12th-grade Girls

	a)	b)	c)	d)	e)	f)	g)	h)	i)	j)	k)	l)
a)Apt-V		.60	.69	.40	.25	.29	.19	.15	.24	.32	.20	.31
b)Apt-M	.60		.52	.52	.26	.30	.33	.28	.40	.46	.44	.40
c)Ach-E	.69	.52		.60	.19	.26	.17	.09	.17	.24	.21	.29
d)Ach-M	.40	.52	.60		.21	.22	.25	.15	.30	.33	.35	.39
e)P.M.-A*	.25	.26	.19	.21		.40	.20	.27	.32	.53	.30	.20
f)P.M.-B*	.29	.30	.26	.22	.40		.38	.39	.43	.72	.39	.22
g)P.M.-C*	.19	.33	.17	.25	.20	.38		.37	.42	.69	.43	.10
h)P.M.-D*	.15	.28	.09	.15	.27	.39	.37		.37	.65	.36	.13
i)P.M.-E*	.24	.40	.17	.30	.32	.43	.42	.37		.83	.49	.15
j)P.M.+	.32	.46	.24	.33	.53	.72	.69	.65	.83		.58	.22
k)D.48++	.20	.44	.21	.35	.30	.39	.43	.39	.49	.58		.19
l)Yrs-M	.31	.40	.29	.39	.20	.22	.10	.13	.15	.22	.19	

*Progressive Matrices (1938) sub-test.

+Progressive Matrices (1938) total score.

++The D. 48 Test total score.

the total score and five sub-test scores of this instrument, and one D. 48 Test item, #23.

The 43 remaining items and total score on The D. 48 Test cluster in factors I, II, III, V, and VI as follows:

Factor	Item Numbers
I	19, 14, 16, 18, 17, 21, 10, 15, 22, 24, 1.
II	44, 43, 39, 41, 42, 36, 40, 37, 38.
III	13, 3, 5, 11, 6, 4, 2, 7, 12, 10.
V	30, 29, 27, 28, 32, 33, 31, 25, 26, total score-D.48.
VI	9, 8, 34, 35.
(VII	23.)

The clustering of the individual items on The D. 48 Test according to the patterns indicated above is based on no simple causative characteristic pervasive in any one factor group. One could tentatively consider that the clusters were the result of events such as the following: (1) the format of the questions, (2) specific characteristics introduced by the sample used in this study, (3) the nature of the inter-correlations on which the analysis was based, (4) solutions for one group of test items rested more on analytical or verbalized techniques while those for another group were available to synthetic or intuitive types of solution, etc.

The analysis does reinforce the lack of relationship between the scores on the Standard Progressive Matrices (1938) and the scores on The D. 48 Test evident in the coefficient of correlation of .57 obtained in this study between the two instruments. 68% of the variance in the scores on the Standard Progressive Matrices (1938) is not accounted for by the variance in the scores on The

TABLE XII

Factor Loadings for Stated Variables. Ordered Factor Loadings (rotated) Obtained by the Centroid Method for 351 Junior and Senior High School Girls.

	Rotated Factors							
Variable	I	II	III	IV	V	VI	VII	h^2
*19	.6135	.0989	.0784	.0908	.1239	.0591-	.0817	.4261
*14	.6066	.0037	.0089	.0850	.0915	.1058-	.0021-	.3949
*16	.5948	.0018-	.0664	.1135	.0158	.0998-	.0781-	.3874
*18	.5718	.0182	.1857	.0521	.1383	.2519	.0215	.4476
*17	.5503	.0288	.2099	.1685	.0645	.2382	.0594-	.4405
*21	.5419	.1334	.0475	.0080-	.0536	.0491	.1972	.3579
*20	.5205	.0990	.0601	.0922	.0332	.0978	.2800	.3819
*15	.5172	.0434	.1015	.0043-	.1082	.1115-	.1797	.3362
*22	.3760	.0020-	.2026	.0577	.0763	.3130	.0711	.2946
*24	.2858	.1300	.1078	.0124-	.0847	.2829	.0596-	.2011
* 1	.1328	.0274-	.1033-	.0465-	.0609	.0272	.0755	.0414
*44	.0276	.6407	.1230	.0155	.0247-	.0511	.0259-	.4305
*43	.0319	.5548	.1998	.0333	.0326	.0006-	.0124-	.3511
*39	.0834	.5099	.0448	.0996	.1384	.1450	.1210	.3337
*41	.0619	.4932	.0745	.0038-	.0392-	.0940	.0853-	.2703
*42	.0447	.4608	.0344	.0515-	.0226-	.0696	.0236	.2241
*36	.1001	.4455	.0446-	.0225	.1942	.0025	.1366	.2674
*40	.0118	.4251	.0004-	.0576	.0965	.0564	.0337	.1978
*37	.0025-	.3689	.1218-	.1179	.1010	.0609-	.0866	.1862
*38	.0329	.1985	.1286-	.0154	.1079	.0458-	.1305	.0880
*13	.1732	.0021-	.4467	.0332-	.0574	.0227-	.1862	.2691
* 3	.0655	.0311-	.3880	.0320	.0984	.0811-	.0336-	.1743
* 5	.0949	.0083-	.3751	.1048	.1065	.0357	.1377	.1924
*11	.1767	.0149	.3446	.0768-	.1732	.0262	.1063	.1981
* 6	.0324	.0431	.3441	.0586	.0621	.0534-	.1547	.1554
* 4	.1194	.1007	.3278	.0558	.0207-	.1035	.1411	.1660
* 2	.0219-	.0732	.2823	.1055	.0090	.0548-	.0745	.1053
* 7	.0735	.0495-	.2543	.0995	.1472	.1278	.1774	.1519
*12	.2407	.1406	.2441	.0922-	.1030	.0127	.0892	.1646
*10	.1656	.0873	.2239	.0006	.0265	.0555	.2213	.1379
Ach-E	.0050-	.0757	.0450	.7457	.0530	.1262	.0853	.5898
Apt-V	.0002-	.1001	.1221	.7061	.0996-	.1195	.1861	.5824
Apt-M	.1470	.0821	.0446	.6706	.1944	.1451	.3063	.6326
Ach-M	.0959	.0789	.0629	.6378	.2163	.0618	.1393	.4962
Yrs.-M	.1336	.0865	.0189-	.4662	.0590	.1685-	.1334	.2927
E.G.-4	.0909	.0918-	.0899	.2098	.0301-	.0785	.0698-	.0807
*30	.0871	.0733	.2480	.0565	.6943	.0799	.0069	.5662
*29	.0979	.1955	.1177	.0292	.6843	.0954	.0516	.5426
*27	.1673	.1097	.0037-	.0388-	.6089	.1523	.1379	.4545
*28	.1675	.1992	.0574	.0070-	.5622	.0351	.0478	.3907
*T.Score	.5395	.3443	.3845	.1189	.5534	.2589	.2743	1.0000
*32	.1363	.0011	.0585	.0411	.4206	.1083	.1090	.2242
*33	.0158	.1204	.1634	.1366	.3597	.2784	.0397	.2686

Table XII (cont'd)

	Rotated Factors							
Variable	I	II	III	IV	V	VI	VII	h^2
*31	.0785	.0331-	.1324	.2117	.3113	.2197	.1470	.2364
*25	.0546	.0706-	.1216	.0700	.2288	.0903-	.2042	.1300
*26	.1058-	.0261-	.0440	.0968	.2082	.0348-	.1936	.1052
E.G.-1	.0638-	.1606	.2259-	.0473	.1588	.6697	.0220	.5573
* 9	.1349	.0201	.2037	.0426	.1870	.3775	.2120	.2843
E.G.-2	.0440-	.1367-	.1568	.0941-	.1848-	.3769-	.1287	.2468
E.G.-3	.0369	.0259-	.0491	.0465-	.0133	.3638-	.1388-	.1584
* 8	.0000	.0402	.2941	.0557-	.1629	.3063	.2125	.2567
*34	.0031-	.0134	.0733	.1711	.1818	.2688	.1823	.1734
*35	.1147	.0907	.0937-	.0840	.2042	.2191	.1450	.1479
+T.Score	.1845	.0894	.1976	.1142	.1590	.1542	.9290	1.0000
+E	.1425	.0826	.1296	.1137	.2152	.2020	.6368	.5496
+B	.2142	.0537	.1895	.1737	.0158	.0630	.6018	.4812
+D	.1666	.0410	.1603	.0842	.0876	.0263	.5391	.3596
+C	.1283	.0451	.2168	.0842	.1934	.1719	.4988	.3883
+A	.0798	.1110	.1706	.2152	.0140-	.0325	.4429	.2915
*23	.0137-	.0309	.1539	.0687	.1011	.1351-	.1687	.0864
Sums Sqs	3.6580	2.4651	2.1150	2.6064	3.1302	1.9805	3.4188	19.3477
Percent Variance	.1891	.1274	.1093	.1347	.1618	.1024	.1767	

*: individual item or total score on The D. 48 Test.

+: sub-test score or total score on Standard Progressive Matrices (1938).

D. 48 Test in spite of the described "good g-test" quality of each instrument.

(3) The performance of the sample of high school students on the Standard Progressive Matrices (1938) and The D. 48 Test.

The means and standard deviations of the scores obtained by the sample, classified by year in school and ethnic group membership, on the Standard Progressive Matrices (1938) and The D. 48 Test are given in Tables XIII and XIV.

These group scores indicate that the two instruments tend to discriminate between year in school (grade 9 through 12) but not between ethnic group, excluding the Chinese group from the analysis of data. This trend is more noticeable in The D. 48 Test scores than in those obtained on the Standard Progressive Matrices (1938)--probably because the sample distributes itself more judiciously among year in school and ethnic group membership cells in the former case.

From Tables XV and XVI the following inferences may be made about the two tests.

(1) Point-biserial correlations of items with total score and proportion of the sample passing each item indicate that The D. 48 Test has the potential to discriminate among a sample of testees in terms of increasing level of difficulty. Several of the items of misplaced difficulty level should be interchanged to maximize this potential.

(2) The Standard Progressive Matrices (1938) is a cyclic test; one would expect to note between as well as within sub-tests an increasing difficulty level. On the basis of scores obtained for the sample used in this study, the test structure

TABLE XIII

Standard Progressive Matrices (1938) and The D. 48 Test: Mean Performance by Year in School[1]

Year in School	P.M.('38) Mean	s.d.	N	D.48 Test Mean	s.d.	N
4	48.18*	5.2585	367	25.33**	5.3983	361
3	47.44	5.1991	241	24.34	5.5896	261
2	45.91*	5.9686	87	23.77	5.6784	282
1	45.12**	5.8466	42	22.24**	5.9807	330
$_{w}M_{t}$	47.49	5.5682	737	23.94	5.6367	1234

[1]Ethnic group 4 not included in analysis.

**t sig. > .01; *t sig. > .05

TABLE XIV

Standard Progressive Matrices (1938) and The D. 48 Test: Mean Performance by Ethnic Group

Ethnic Group	P.M.('38) Mean	s.d.	N	D.48 Test Mean	s.d.	N
1	47.75	5.1482	486	24.20	5.9009	869
2	47.36	5.6293	162	23.41	5.6427	263
3	46.35	6.0533	89	23.04	5.2042	102
$_{w}M_{t}$	47.49	5.5682	737	23.94	5.6367	1234

TABLE XV

Standard Progressive Matrices (1938): Point-Biserial Correlations of Each Item with Total Score and of Sub-Test Scores with Total Score; Proportion Passing Each Item. N = 753

Item No.	r_{pbis}	p	Item No.	r_{pbis}	p
A - 1	-.022	.999	C - 1	.001	.989
2	.038	.990	2	.252	.958
3	-.010	.999	3	.169	.975
4	.061	.995	4	.200	.834
5	.153	.996	5	.273	.952
6	-.040	.999	6	.228	.837
7	.213	.954	7	.305	.918
8	.182	.942	8	.303	.596
9	.168	.984	9	.150	.854
10	.208	.959	10	.351	.580
11	.340	.882	11	.245	.584
12	.338	.715	12	.186	.101
A-total sc.	.570		C-total sc.	.626	
B - 1	.088	.993	D - 1	.140	.999
2	.161	.989	2	.126	.981
3	.118	.992	3	.126	.997
4	.240	.951	4	.186	.931
5	.370	.926	5	.129	.967
6	.304	.898	6	.206	.968
7	.342	.829	7	.257	.854
8	.331	.861	8	.337	.834
9	.319	.919	9	.263	.807
10	.333	.952	10	.360	.857
11	.324	.899	11	.129	.319
12	.376	.705	12	.251	.274
B-total sc.	.684		D-total sc.	.611	
			E - 1	.274	.862
			2	.403	.807
			3	.377	.738
			4	.526	.697
			5	.517	.761
			6	.384	.566
			7	.355	.596
			8	.439	.462
			9	.321	.402
			10	.319	.187
			11	.044	.045
			12	.020	.106
			E-total sc.	.757	

TABLE XVI

The D. 48 Test: Point-Biserial Correlation of Each Item with Total Score; Proportion Passing Each Item

Item No.	r_{pbis}	p	Item No.	r_{pbis}	p
1	.239	.992	22	.444	.487
2	.249	.979	23	.283	.442
3	.331	.952	24	.338	.331
4	.311	.972	25	.238	.097
5	.409	.870	26	.155	.143
6	.335	.944	27	.533	.604
7	.370	.847	28	.476	.699
8	.428	.785	29	.513	.542
9	.458	.670	30	.510	.675
10	.405	.866	31	.361	.360
11	.424	.847	32	.397	.206
12	.393	.909	33	.391	.592
13	.357	.919	34	.324	.202
14	.383	.901	35	.305	.115
15	.424	.840	36	.303	.285
16	.418	.863	37	.223	.209
17	.519	.527	38	.175	.070
18	.541	.590	39	.352	.187
19	.506	.791	40	.284	.106
20	.474	.761	41	.141	.080
21	.497	.682	42	.146	.040
			43	.243	.057
			44	.174	.054

N=1265

appears to implement the pattern of increasing sub-test and test item difficulty. Sub-tests A and B contain too many easy items to discriminate efficiently among these subjects.

Conclusions

The following conclusions concerning the Standard Progressive Matrices (1938) and The D. 48 Test are drawn from analysis of data gathered for a sample of 1579 high school girls of differing ethnic and cultural backgrounds.

(1) Scores on the Standard Progressive Matrices (1938) and The D. 48 Test appear to be related to measures of mathematics aptitude and achievement. One can hypothesize that this relationship probably has its base in facility in or preference for reasoning with symbolic types of material.

(2) Neither the Standard Progressive Matrices (1938) scores nor those on The D. 48 Test are validly predicted from indices of academic performance used in this study. Only about one-fifth of the variance in scores obtained on the former test and one-fourth of the variance in scores obtained on the latter were accounted for by variance obtained on measures of the independent variables used in this analysis.

(3) Scores on the Standard Progressive Matrices (1938) and The D. 48 Test appear to discriminate successfully between high school years. The two tests do not appear to differentiate among ethnic groups used in this study. However, the four ethnic groups has the same mean occupational status rank, 5.5. The instruments may differentiate within ethnic groups as one moves up or down the socio-economic ranks.

(4) The construction of The D. 48 Test is faulty in terms of

increasing difficulty level of the items. However, it seems to have a more appropriate ceiling for use with this group than the Standard Progressive Matrices (1938).

(5) Both the Standard Progressive Matrices (1938) and The D. 48 Test are described as "good g-tests". Nevertheless, the instruments appear to be measuring different aspects of intellectual capacity. In this study only about 32% of the variance in the scores obtained on the Standard Progressive Matrices (1938) was accounted for by variance in scores obtained on The D. 48 Test.

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